# SEPARATION OF CRUDE OIL EMULSION VIA ULTRASONIC TECHNOLOGY

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I declare that this thesis entitled "*Separation of Crude Oil Emulsion Via Ultrasonic Technology*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name of Candidate: SITI ZALEHA BINTI ABDULLAH

Date :

Special Dedication of This Grateful Feeling to My…

***Beloved father and mother;***
***Mr.Abdullah Hj Saleh and Mrs. Mariah Ismail***

***Loving brothers and sisters;***
***Adenan and Siti Asmah***

***Supportive friends;***
***Norsuzieana and all my friends***

For Their Love, Support and Best Wishes.

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## ABSTRACT

Emulsions have long been of great practical interest due to their widespread occurrence in everyday life. They may be found in important areas such as food, cosmetic, pharmaceutical and agricultural industry. Emulsions are also found in the petroleum industry. Water separated from water in oil emulsion by various method such as ultrasonic, chemical or microwave demulsification. Emulsifier are surfactant used to develop high surface pressure at emulsion interface. In this research the ultrasonic technology used to break the water in oil emulsion. For stability part, about three type of crude oil used in the stability part which are include heavy and light crude oil. The emulsion prepared by mix the crude oil with the emulsifier such as Span 80.Tween 80 and SDDS and the propeller will used to mix the mixture vigorously for 5 minute. The next step pour some water slowly into the crude oil and wait until 10 minutes to ensure the mixture is completely mixing.The speed for propeller is about 1250rpm.the sample will check water in oil emulsion by filter paper or test tube test.Record the data and observed what happen occur during experiment. For the demulsification part the Masila crude oil will used to compare the ultrasonic with chemical demulsification method. The hexylamine is the chemical used to break the emulsion.The data and observation will be record and graph will be plotted to show which one give best performance to break the emulsion.In conclusion the ultrasonic is not effienct method to break the emulsion compared to the chemical method.

# ABSTRAK

Emulsi sudah lama tersebar luas yang berlaku dalam kehidupan seharian. Ia berkemungkinan dijumpai dalam bidang penting seperti makanan,kosmetik,farmasi dan industri pertanian. Emulsi juga dijumpai dalam industri petroleum. Permisahan air dari emulsi dengan pelbagai cara seperti ultrasonic,kimia atau gelombang micro. Pengelmusi ialah *surfactant* yang digunakan untuk membantu menaikkan tekanan di permukaan emulsi. Dlama kajian ini teknologi ultrasonic adlah cara yang digunakan untuk memisahkan emulsi .Untuk bahagian kestabilan emulsi tiga jenis minyak petroleum digunakan termasuk minyak petroleum yg mempunyai struktur molekul yang komplek dan ringkas. Persediaan emulsi adalah dengan mencampurkan minyak dengan pengelmusi seperti *Span 80,Tween 80* dan juga *SDDS* dan pengadun akan digunakan untuk mengadun campuran selama 5 minit. Peringkat seterusnya air dimasukkan perlahan-lahan ke dalam campuran minyak dengan pengelmusi selama 10 minit untuk memastikan bahawa campuran emulsi tadi betul betul bercampur. Kelajuan pengadun di setkan sebanyak 1250 rpm dan sampel diuji dengan kertas turas atau ujian tabung uji untuk memastikan jenis emulsi mengikut yang dikehendaki. Data dan pemerhatian direkodkan sepanjang eksperiment dilakukan. Bagi bahagian untuk pemisahan emulsi pula,minyak Masila digunakan untuk membandingkan cara pemisahan menggunakan ultrasonic dengan cara pemisahan secara kimia. Cecair kimia Hexylamine digunakan untuk memisahkan emulsi.Data dan pemerhatian direkodkan kemudian plot grraf untuk menunjukkan cara mana yang terbaik untuk memisahkan emulsi yang berlaku. Kesimpulannya, cara ultrasonic adalh tidak effisen untuk memisahkan emulsi jika dibandingkan dengan cara pemisahan secara kimia.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The petroleum industry usually involved with process of exploration, extraction, marketing the petroleum product and so on. As it known that the petroleum is the main raw material to produce a lot of chemical product such as plastic, pesticides, pharmaceutical and many more. The petroleum consists of hydrocarbon chains in their chemical structure at different lengths. Hydrogen and carbon are two main atomic involved in hydrocarbon chain which are come in straight branching chain to rings. There are varies types of process to separate the petroleum to be used in variety of purpose. The most common of petroleum separation is distillation. From this separation there are a lot of product will produce such are gasoline, kerosene, fuel and so on at different temperature depend on their boiling point. The crude oil usually comes out from underground of the reservoir. The characteristic of the crude oil are smelly and yellow to black liquid.

Water is normally present in crude oil reservoir or is injected as steam to stimulate oil production (Abdurahman et-al 2007). The mixture of this substance cause the phenomenon called emulsion. Emulsions are found in a variety of industries, from food and pharmaceuticals to petroleum production and refining. An emulsion is a system consisting of a liquid dispersed in an immiscible liquid. Immiscible means not

compatible or not be able to mix together to make a solution. Oil and water are great examples of two immiscible liquids (Anne et-al, 2008). ). The separation of water from oil is a bottleneck in the offshore oil production. When oil and water is processed from the well-head to the manifold, pressure drops occurring over chokes and valves crush water droplets in the oil phase to stable water-in-oil (w/o) emulsion. Because of a large area to volume ratio, factors which affect the interfacial properties are of crucial importance in defining the level of stability encountered in crude oil emulsions from different wells or with different treatment strategies. There are three types of emulsion which are flocculation, creaming and coalescence. The flocculation occur when the particles form clumps meanwhile the creaming occur when the particle concentrate towards the surface depend on the density of the two phases of mixture while separate and breaking. In addition the emulsion also suffers from coalescence. Coalescence occur during the particle coalesce and form a layer of liquid.

Water-in-crude oil emulsions stabilized by various surface-active components are one of the major problems in relation to petroleum production. The surfactants are usually present in the oil phase. The mechanism for emulsion stabilization in petroleum and petroleum-derived fluids is not completely understood. Many attribute emulsion stability to the viscoelastic interfacial film mentioned previously. This skin is formed through the interactions of the surface-active molecules in the crude, which fall into two main categories, asphaltenes and resins.Formation of these emulsions during oil production is a costly problem both in terms of chemicals used and due to production losses (Abdurahman et-al 2007).

## 1.2 Problem Statement

Emulsions in refinery processes lead to sludge generation, high costs for recovering slop oils, and other problems. One of the largest problems in oil production is the formation of emulsions stabilised by heavy crude oil components like asphaltenes,

resins and waxes. Such problems may in some cases be solved by means of injections of chemicals or introduction of mechanical separation facilities. However, the costs of these solutions are normally high and the search for new and efficient separation tools is important. Besides, the equipment also tend to damage because of emulsion. Usually all the equipment used in industry is huge and expensive, so it needed more cost to repair the maintenances of the equipment. This tow major problem that the industry to face it nowadays.

## 1.3 Objectives

I. To study the intensive demulsification of highly stable water-in-crude oil and understand the mechanism of demulsification using ultrasonic and chemicals.
II. Comparison between ultrasonic of chemical demulsificatio

## 1.4 Scope Of Research

Based on the objective above, several scopes have been outlines which are:

1) The potential of ultrasonic in demulsification of water in crude oil emulsions
2) Varying the power range via ultrasonic technology
3) Overall study of water in crude oil emulsion
4) The comparison between chemical and chemical method

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Separation

In the chemical and other physical processing industries the separation process have certain fundamental and basic principles in common. Separation processes can essentially be termed as mass transfer processes. However the term of unit operations has largely been superseded by the modern term separation process. These separation processes are common to all types of diverse process industries. A separation process is used to transform a mixture of substances into two or more distinct products. The desire products that form after separation process could differ in two characterizations such as chemical properties and physical properties. It can be characterize depend on it size, shape, color, crystal modification and so on. The classification of the separation based on mechanical or chemical which is chemical separation possible due the high cost of the operation rather than mechanical separation (Christie et al, 2003). Chemical separation is remaining solution if the system cannot separate purely by mechanical separation. There are many classification of separation process such as list in the table below:

Table 2.1: Type of Separation

| Separation process | Meaning |
|---|---|
| 1. Evaporation | This refer to the evaporation of a volatile solvent such as water from a nonvolatile solute as salt or any other material in solution |
| 2. Drying | In this operation volatile liquids usually water are removed from solid materials |
| 3. Distillation | This is an operation whereby components of a liquid mixture are separated by boiling because of their differences in vapor pressure |
| 4. Absorption | In this process a component is removed from a gas stream by treatment with a liquid |
| 5. Membrane separation | This process involves the separation of a solute from a fluid by diffusion of this solute from a liquid or gas through a semi permeable membrane barrier to another liquid |
| 6. Liquid-liquid extraction | In this case a solute in a liquid solution is removed by contacting with another liquid solvent that is relatively immiscible with the solution |
| 7. Adsorption | In this process a component of a gas or liquid stream is removed and adsorbed by a solid adsorbent |
| 8. Ion exchange | Certain ions in solution are removed from a liquid by an ion-exchanged solid |
| 9. liquid-solid leaching | This involves treating a finely divided solid with a liquid that dissolved out and removes a solute contained in the solid |
| 10. Crystallization | This concerns the removal of a solute such as a salt from a solution by precipitating the solute from the solution |

The most important thing about the separation process is it can separate in various types of separation or can be combined in various sequences in a process depends on it raw mixture. Separation applications in the field of chemical engineering are very important. A good example is that of crude oil. Crude oil is a mixture of various hydrocarbons and is valuable in this natural form

## 2.2 Crude Oil

The oil we find underground called crude oil. Crude oil is a naturally occurring substance found in certain rock formations in the earth. These were produced when tiny plants and animals decayed under layers of sand and mud millions of years ago. As these plants and animals die, they sink to the bottom of the sea where they mix with mud, sand, and clay. Year-after-year more mud and sediments are deposited on the sea floor. Over millions of years the layer of organic mud becomes buried thousands of feet deep in the earth. The temperature of the earth becomes hotter as you go deeper into the earth and the weight of all the mud and rocks above increase the pressure.

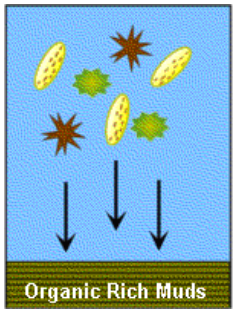


Figure 2.1: Process crude oil occur

The combination of increased temperature and pressure will change the organic material to crude oil. As the temperature increases the crude oil can be changed into natural gas.


Figure 2.2: Process convert mud to oil

Crude oil does not look the way depend on where it comes from. It is a dark, sticky liquid which and classified as a hydrocarbon. These substances are mainly compounds of only two element which are carbon (C) and hydrogen (H). Refining crude oil involves two kinds of processes to produce the products so essential to modern society. First stage, there are physical processes which simply refine the crude oil into useful products such as lubricating oil or fuel oil. Second part, there are chemical or other processes which alter the molecular structure and produce a wide range of products, some of them known by the general term petrochemicals. As we know that the crude oil is highly flammable and can be burned to create energy.

## 2.3 Hydrocarbon

Hydrocarbon is the simplest organic compound consists of carbon and hydrogen. It can be straight chain, branched chain or cyclic molecules. Carbon tends to form four bonds in a tetrahedral geometry. Most of the hydrocarbons found naturally occur in

crude oil. Hydrocarbons exist in liquid, gaseous or solid at normal pressure and temperature depending on the number and the arrangement of carbon atom in the molecules. Crude oil in liquid phase but maybe contain gaseous or solid compound in solution. The more carbon contain in the molecules it has tendency to being a solid especially the heavy crude oil. The simplest hydrocarbon is methane which is contain one carbon and bounded with four hydrogen atoms. The picture below show the molecule structure of methane

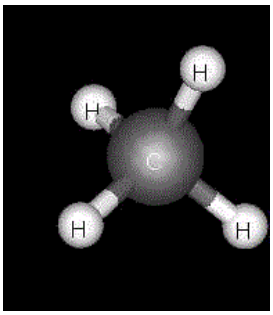


Figure 2.3: Methane (CH4) molecule structure.

A carbon atom has four bonds that can be connected with either one or more the carbon atom or another atoms element meanwhile the hydrogen atom only can unite with one atom only. The larger hydrocarbon has more carbon atoms joined to one another as well as to hydrogen atoms for example the propane (C3H8) which is exist in straight chain molecule and a branched chain structure like isobutene (C4H10) as shown below.

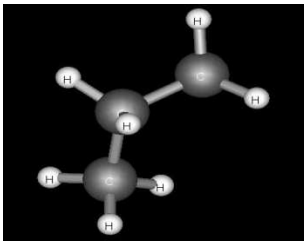

Figure 2.4: Propane (C3H8) molecule structure.

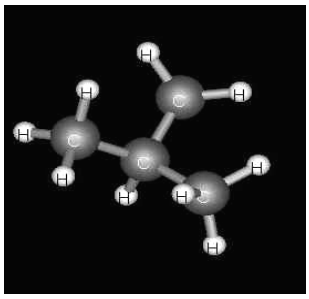

Figure 2.5: Isobutane (C4H10) molecule structure

The hydrocarbon can becomes complex. It is more complex when more hydrogen atoms replaced by hydrocarbon group or stacking of one or more ring. The naphthalene is the simple example shows the complex structure of hydrocarbon. At this point we can see the molecules structure found in the crude oil.

### 2.3.1 Types Of Crude Oil

Crude oil varies widely in appearance which range in color and properties they contain. Most of crude oil essentially hydrocarbon with difference in properties because the variations in the molecule structure. The variation may influence its suitability and quality of the product. Crude roughly divided in three groups depends on the nature hydrocarbon they contain.

1. **Paraffin Base Crude Oils**

These contain higher molecular weight paraffin which are solid at room temperature but it contain little or no asphaltic matter. They can produce high-grade lubricating oils.

**2. Asphaltic Base Crude Oils**

It consist large proportions of asphaltic matter and little or no paraffin. Some are predominantly naphtenes so yield lubricating oil is more sensitive to temperature changes than the paraffin base crudes.

**3. Mixed Base crude Oils**

Both paraffins and naphtenes are present as wellas aromatic hydrocarbons. Most crude fit this category.

### 2.3.2 Crude Oil Quality

The physical characteristics of crude oils differ. Crude oils are classified depends on their density and sulfur content in it. Crude generally have a higher share of light hydrocarbons classified as less dense which can be recovered with simple distillation and higher value products. Meanwhile, the denser or heavier crude oils produce a greater share of lower-valued products with simple distillation too. It is requires additional processing to produce the desired range of products. Some crude oils have a higher sulfur content with respect to both processing and product quality. For pricing purposes the crude oils with similar quality are often compared to a single representative crude oil. The quality of the crude oil dictates the level of processing and re-processing necessary to achieve the optimal mix of product output. Hence, price and price differentials between crude oils also reflect the relative ease of refining. In addition the type of hydrocarbon molecules and other natural characteristics may affect the cost of processing or restrict a crude oil's suitability for specific uses. The presence of heavy metals causes contaminants to the processing and to the finished product. The molecular structure of a crude oil also dictates whether a crude stream can be used for the manufacture of specialty products, such as lubricating oils or of petrochemical feed

stocks. Refiners put some effort to run the optimal mix of crude through the refineries depends on their equipment, the desired output and the relative price of available crude

### 2.3.3 Crude Oil Composition

Crude oil is a complex mixture of hydrocarbons which consists of sulfur, oxygen, nitrogen, as well as various metallic constituent like nickel, copper, iron and so on. The element contain in crude oil are carbon (83.9-86.8%), hydrogen (11-14%), sulfur (0.06-8.00%), nitrogen (0.02-1.70), oxygen (0.08-1.82) and metal (0.00-0.14). Even though crude oil continuum with thousands different hydrocarbon molecule but the proportions of the elements in crude oil vary over fairly narrow limit. The SARA method is one example of separate the crude oil into four major fraction or chemical classed based on difference solubility and polarity. The four fraction are the saturates (S), aromatics (A), resins (R) and last but not least is the asphaltenes (A). The schematic of SARA method shown as below (Inge et al, 2002).

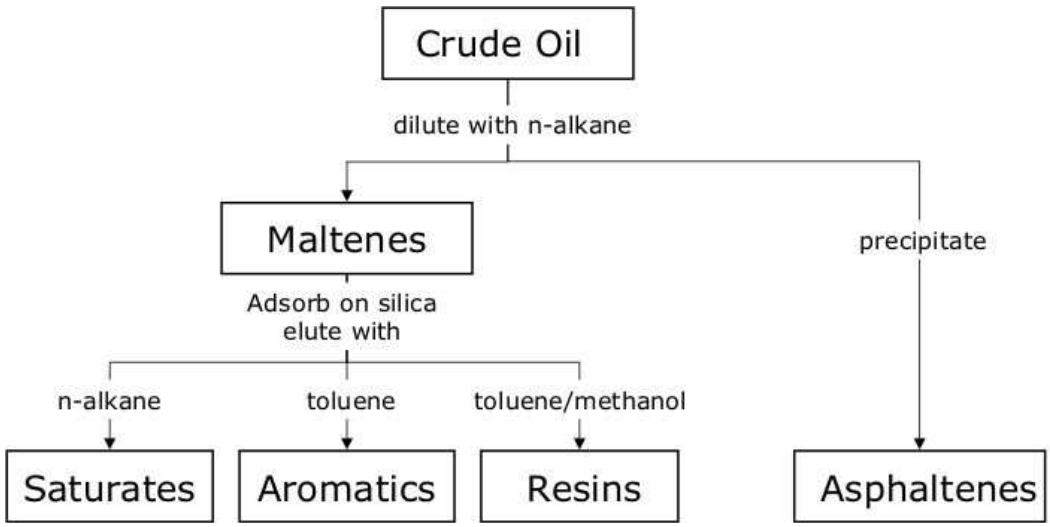


Figure 2.6: SARA separation scheme (Narve et a,l 2002